PITCHER PLANTS.

BY JOSEPH F. JAMES.

THERE are two widely separated orders of plants known by the common name of pitcher plants, and they are perhaps, as widely separated in a natural classification as they are in their habitats. While one order is placed near the poppies and is a native of America, the other is allied to the birthworts or the Aristolochias, and lives in the swamps of Southeastern Asia, and the islands of the Malay archipelago. The first of these orders is known scientifically as Sarraceniaceæ, and includes but three genera; the other is Nepenthaceæ, with but one genus. Both of them are more or less familiar to persons interested in plants, and the latter always attracts attention by the peculiar appendage, like a bird's nest to the eyes of some, which is suspended from the tip of the leaf. It is to the first of these orders, the members of which are, with a solitary exception, natives of the United States, that this paper is devoted.

The genus Sarracenia, named in honor of Dr. Sarrazin, of Quebec, who first sent the plant and an account of it to Europe, comprises eight species, all but one of them being confined to the Southern States of our country. The one with the widest distribution, the well-known side-saddle flower, extends from near Florida, through the Atlantic Coast States to New England, and thence westward along the northern boundary of the country and in Canada, into British America. It lives in the cold swamps and bogs of the North, and its peculiar leaves and flowers have always been remarked by those who have collected or have seen them. The inside of the hood of the leaf is covered with a closely set mass of hairs, in all cases pointing downwards into the tube. In a state of nature these aptly named pitchers are often half filled with water; and the water is generally so crowded with insects, dying or dead, and decaying, that the air in a swamp where numbers of the plants are growing is very offensive.

At the junction of the hood to the main portion of the leaf, the hairs end abruptly, and the inside becomes very smooth and polished. This continues to about the middle of the pitcher, when another set of hairs is met with, this time not so stiff as at the top, but all of them still pointing downward toward the bottom.

This peculiar arrangement of a set of hairs at the apex of the leaf, of a smooth portion near the middle, and another set of hairs near the base, obviously serves some use in the economy of the plant. When the young leaves first open, there is no water found in them, but as they are so open and exposed to all rains and storms, they readily become partially filled with water. Now this soon becomes a mass of decayed animal matter. Insects fly, or fall into the tube, and once in, there is no egress. The fringe of hairs at the base hinders their walking, and even if this be surmounted, and the smooth stretch passed, the hairs on the hood, a veritable *chevaux-de-frize*, stops his onward and upward progress. He loses his foot-hold among the many hairs and falls hopelessly back to the bottom, to be eventually either drowned or starved.

It has often been a matter of surprise to see the number of insects in these pitchers, and it is more notably so because there seems to be so little to take them there; so little to induce them to tumble into the trap spread for them. But in thinking the matter over and taking into consideration one or two curious coincidences, it has occurred to me that this may be explained as follows: The flower is of a peculiar structure, is nodding on a naked scape, and the stamens with their mass of pollen are concealed behind the broad, peltate stigma, which forms, in fact a sort of reversed table. An observer, Mr. J. Jackson, Jr., has recorded (*Bot. Gaz.* VI, p. 242) that in examining a number of flowers, he has found the cavity between the inner surface of the stigma and the stamens, to be filled with flies, apparently eating the pollen. Fourteen flies were counted on one flower, and were, as he states, "in no hurry to vacate the premises." The suggestion I would make is this: If we suppose that there is something in the pollen, or in some secretion of the flower which has the effect of stupefying or intoxicating the insect, a not improbable supposition by any means, and then imagine a smart wind shaking the flower vigorously, would not the tendency be to shake the flies from their hold, partially stupefied as they are? They would drop to the ground, or else into the pitchers opened below them. These in their turn are admirably adapted to catch falling insects, for the hood is upright, and the cavity of the leaf fully exposed. The leaves too are spread out in a sort of rosette, quite close together, and all so inclined as to bring the opening in the most favorable

position to catch any falling object. What then is to prevent the leaf from securing its prey? And should it be so, it would be strange to find the flower used as a lure to bring food to the plant. It is said that a slight secretion has been detected about the orifice of the pitcher of this species, but Dr. Gray considers it to possess but little efficiency in securing the multitudes of flies sometimes found in the pitchers. The suggestion here made is, I think, worthy of consideration, and will not appear so very improbable when we come to other facts in relation to our subject.

Turning now to another species let us see what other facts can be learned, and see, too, what bearing they may have on the facts ascertained in regard to *Sarracenia purpurea.* The *Sarracenia flava* is a Southern species, extending from Virginia to Florida, and inhabiting the same swampy places which are the favorites with *S. purpurea.* The *flava* differs in a marked manner from the *purpurea.* The pitchers are much taller, stand more upright, and the lobe at the top is wider and more spreading. The inner surface of the hood has much smaller hairs, so small that it might be called a fine pubescence. But a still greater difference is found in the fact that there is a saccharine secretion found on the inner side of the hood, just above the junction of the lid with the rim. But there is something in regard to this secretion which is quite interesting. It has been stated by some observers, and it is thought with truth, that the secretion possesses intoxicating or stupefying qualities. As the insect feeds upon the matter it becomes dizzy, loses its hold on the surface of the hood, and falls to the bottom of the tube. Dr. Gray says in regard to this secretion at the orifice of the pitcher (*Am. Jour. Sci. and Arts*, ser. III, vol. 6; p. 149-50) that "This made its appearance at first in the form of minute drops, distinctly visible only under a lens; at length it forms flattened drops and even patches, distinctly sweetish to the taste and viscid to the touch." Mr. Brady, who observed the plants in North Carolina, says in regard to some pitchers of this species, "These, brought into the house, and kept fresh by the immersion of the base in water, showed the saccharine secretion most abundantly about a quarter of an inch above the junction of the lid with the rim. * * * * Many flies settled on the lids, and feasted on the saccharine narcotic. Evident signs of intoxication were manifested in each case, by their breaking loose repeatedly before tumbling into the gulfs." (*Am. Jour.*, ibid, p. 468.)

It is well known, as has been already noted, that the insects found in the leaves of the *S. purpurea*, meet their death by drowning, but with the *S. flava* the case is different. In regard to this Dr. Gray says (*Am. J.*, ibid, p. 149-50): "That the insects which abundantly fall or find their way into Sarracenia pitchers do not generally escape, but die and decompose there, is obvious. That more commonly they do not perish by drowning in *S. flava* is equally clear. While all the lower and gradually attenuated part of the tube is filled with dead flies in our plants growing in the house, there is only a little moisture at the very bottom. One would hardly think that the fine and sharp-deflexed bristles, which line the lower half of the tube only in *S. flava*, would greatly impede the return of a fly, they lie so closely against the wall of the tube. But I find that a house-fly, either large or small, when thrown into this lower part of the tube, is quite unable to get out, and there it perishes. Probably the advantage derived by the plant is equally secured, whether their prey decomposes in the moist air of the cavity or in the water in which they are often immersed."

This water, which is in the lower portion of the tube of *S. flava*, is also a secretion of the plants, for Dr. Gray and Mr. Canby found that "it distils in drops from the inner surface of the young pitcher, before the orifice is open." (Ibid, p. 149). The amount becomes afterward greatly increased by the rain which falls without difficulty into it.

There is, in a third species, this same sort of a secretion, with apparently the same stupefying effects. This is the *Sarracenia drummondii;* it has upright leaves which sometimes grow to be three feet in length, and they are peculiarly mottled with white spots. The hood has much larger and more conspicuous hairs than in the former species, and it is on this hood that the secretion is formed. Dr. Chapman, in writing to Mr. Canby, says: "On the inside of the hood, above its junction with the tube, there is a very faintly sweetish secretion scarcely perceptible to the taste, which is very attractive to insects; and, as I do not detect any of this within the tube, I wonder how it happens that so many insects are entrapped, since they could easily fly away from the open hood" (*Am. Jour.*, ibid, p. 468). Here again the stupefying qualities of this secretion are manifested, for it is after the insects have partaken of it that they are unable to fly away, and so fall into the trap.

Is there not good reason then for the theory I have advanced in regard to some stupefying matter in the flowers of *S. purpurea?* If the secretions of two species have poisonous properties, why should not that of a third have the same power? especially when it probably serves the same end in the economy of the plant, namely, that of providing insect food for it.

We come now to another species of the curious genus, the facts in regard to which are still more wonderful than those already given. This species is the *Sarracenia variolaris*, an inhabitant of the "damp pine lands," flourishing best on the edges of "pine-barren ponds" of Carolina and other Southern States. It differs in a marked manner from the other species noticed, inasmuch as the hood, instead of standing upright and leaving the orifice of the pitcher exposed, is bent over and shuts out most effectually any rain that may happen to fall. According to an excellent observer Dr. Mellichamp, of South Carolina (Pro. A. A. Adv. Sci., vol. 23, 1874), the leaf may be divided into three portions: "First, the inner surface of the hood or upper lid, marked on the posterior portion by white translucent spots and purple recticulations, which last extend forward and upward, and again downward on each side of the rim, for [supposing the leaf to be a foot long] a half an inch, or sometimes an inch." This embraces the internal honey-bearing portion. "Immediately below this, and extending for the space of three inches, there is an exquisitely soft and velvety pubescence, which under the glass is seen to be composed of very fine and thickly disposed retrorse hairs. This may be termed the second belt, and is so smooth as to afford no foothold for most insects. Below this again, the eye may detect a deeper colored pubescence, of a pale yellow or straw color, still smooth, but composed of coarse hairs, which became longer and more bristly as the tube narrows. At the base of this tube a watery fluid is secreted, into which insects are precipitated. This is the third belt and about five inches in length."

Examination of numbers of the young leaves, into which it was impossible for the rain to have found its way, revealed the fact that almost invariably there was some liquid to be found. This was sometimes but a few drops and at others as much as a drachm or even more. Experiments with this fluid brought to light some interesting facts. By great care, the experimenter collected about a half ounce of the liquid and experimented chiefly

with house flies. I give the results in his own words: "About a half drachm to a drachm of the liquid was placed in a small receptacle, and the flies thrown in from time to time, the liquor not being deep enough to immerse them completely, but enabling them to walk about in it without the risk of being drowned. Perhaps twenty flies were experimented with. At first the fly makes an effort to escape, though apparently he never uses his wings in doing so; the fluid though not very tenacious, seems quickly to saturate them, and so clings to them and clogs them as to render flight impossible. A fly when thrown into pure water is very apt to escape, as the fluid will 'run' from its wings, but none of these escape from the bath of the Sarracenia secretions. In their efforts to escape, they soon get unsteady in their movements, and tumble, sometimes, on their backs; recovering, they make more active and frantic efforts, but very quickly stupor seems to overtake them, and they turn on their sides, either dead (as I at first supposed) or in profound anæsthesia.

"I had no doubt from the complete cessation of motion, and from their soaked and saturated condition, that they were dead, and like dead men they were 'laid out,' from time to time, as they succumbed to the powerful liquor; but to my great surprise, after a longer or shorter interval, from a half hour to an hour or more, they indicated signs of returning life, by slight motions of the legs and body. Their recovery was very gradual, and eventually, when they crawled away, they seemed badly crippled and worsted by their Circean bath. After contact with the liquid, the flies first thrown in became still, seemingly dead, in about a half minute; but whether from exposure to the air or exhausted by action on these insects, the liquor did not seem to be so intoxicating with those last exposed to its influence. Anæsthesia or intoxication did not occur so quickly; it took from three to five minutes generally, and in one rebellious 'subject' it was at least ten minutes before he received his *coup de grâce*. A cockroach thrown in succumbed almost immediately, as did also a small moth, and much more slowly a common house-spider. On the recovery of the latter it was almost painful to witness his unsteady motions. Without doubt, therefore, the secretion found in the tubes of *Sarracenia variolaris* is intoxicating, or narcotic, or anæsthetic, or by whatever word we may prefer to indicate that condition to which these small insects succumb."

To still further test the qualities of this fluid, Dr. Mellichamp placed bits of venison in some of the Sarracenia secretion and some in pure water, and he found that in the former at the end of fifteen hours the meat was much more decomposed and gave out a much more offensive odor than in the latter; thus proving that the secretion possessed powers of decomposition.

Turning his attention then to the secretion on the hood of the pitchers, the observer found that it was best developed in warm weather, covering from a half to an inch of the surface. But he also found, what has not been found on any of the other species, "a continuation of the sugary exudation * * * glistening and somewhat viscid along the whole border or edging of the 'wing' —extending from the cleft in the lower lip even to the ground. There is, therefore, a honey-baited pathway leading directly from the ground itself up to the mouth, where it extends on each side as far as the 'commissures' of the lips, from which it runs within and downward, as before stated, for at least half an inch."

This exudation is not, it must be understood, an exceptional thing, but it is invariably found on leaves which are sufficiently mature and favorably placed in regard to the sunlight and moisture. And as showing the extensive use of this baited pathway, it is stated that ants, those prowling insects ever on the search for prey, are most frequently to be found in the pitchers. Further, it should be stated that this honey pathway does not seem at all to possess the anæsthetic qualities of the secretion at the bottom of the tube, but it simply acts as a lure. The flies would eat along the pathway and then enter the tube, either along the inner face of the hood or at the lower side. "After entering (which they usually do with great caution and circumspection appearently), they begin again to feed, but their foothold for some reason or other seems insecure, and they occasionally slip * * * upon this exquisitely soft and velvety 'declining pubescence.' * * * I have seen them," he continues, "regain their foothold after slipping, and continue to sip, but always moving slowly, and with appearent caution, as if aware that they were treading on dangerous ground." When attempting to fly they either strike against the hood, or the sides of the tube and keep falling lower and lower until they reach the liquid at the bottom where they become asphyxiated and at last take the form of the liquid manure which is utilized by the plant. Other experiments seem to show

conclusively that the honey of the lure possesses no intoxicating qualities, and that it is owing to the peculiar pubescence on the inside of the tube which prevents the insect from making its way out by crawling.

For instance, some of the tubes were split open their whole length and smeared with the honey. Then they were placed flat on the table, and a fly which had been smeared with the secretion so it could not fly, was placed upon the pubescent part of the tube. Mark the result: "The fly immediately made an effort to advance, but to my great surprise its most vigorous and persistent efforts availed nothing, as it slowly but steadily retrograded to the lower extremity of the tube! The experiment was repeated frequently, but always with the same result. It was as if a boat with insufficient propulsive power were steadily drifted back by a strong tide, only in this instance the tide seemed to be the polished retrorse hairs, made still more slippery by the fluid, with which also the insect was covered."

But while the large majority of the insects which are found in the pitchers of *S. variolaris* are there to die, there are two, a moth and a fly which live there almost altogether. These have some peculiar modification of the hairs on the legs which enable them to surmount the peculiarly pubescent surface. These insects are, of course, there only for the purpose of rearing their young, for they deposit their eggs, and the larvæ of one feeds on the decayed matter in the pitcher, and of the other upon the tissues of the leaf itself.

We have seen in the contrivances of these four species of Sarracenia a great diversity in order to secure the same end. That end will be evident with but little consideration. It must be for the nutriment of the plant in some way. When we study the Venus fly-trap, or the sun dew, we know that there is some benefit derived from the insect prey they capture. When we see the many marvelous contrivances in the flowers of the orchids, machinery arranged for the sole purpose of producing seed, we do not for a moment consider it chance, but know there is an adaptation of means to an end. And so, when we find in the pitchers of the species of this genus, such obvious traps for insects, we may feel assured that they are for some use. They can only be to supply the plant with nourishment, either as a liquid manure for the roots, transmitted through the cells at the base of the leaf, or else by

some absorbent glands, which takes the matter directly into the tissues of the plant. The probabilities are in favor of the former, or while large tubular cells have been noticed passing down through the base of the petiole into the root (Pro. A. A. A. S., vol. 23, 1874, Nat. Hist., p. 25), there have not been found, I believe, any absorbent glands on the interior surface of the leaf. It is very likely, as has been suggested, that as we find the leaves of Dionœa become less sensitive after a time, and cease to absorb matter, so the leaves of Sarracenia contain much more decaying matter than suffices for their use. This is made use of by various insects, for larvæ of different kinds are found in old pitchers, especially those of the *S. purpurea.* And birds are known to split open many of the pitchers and devour the insects inclosed. Finally, as Dr. Hooker says (Address before Brit. A. A. S., 1874, *Nature*, vol. x, p. 370), "the pitchers decay, and part, at any rate, of their contents must supply some nutriment to the plant by fertilizing the ground in which it grows."

Taking leave now of the genus Sarracenia, let us turn to another genus of the same family, the Darlingtonia, of a still more curious structure. This plant inhabits the bogs of California at an elevation of from 6000 to 7000 feet, and is limited to a very few localities. It was discovered as long ago ago as 1842, but it is so scarce and so few people have had an opportunity of observing it in a state of nature, that we know comparatively little about its structure and habits. What we do know is due to the observations of Mr. J. G. Lemmon and Mrs. R. M. Austin, of California, and to Mr. Canby, who has published an account of the plant. The tubular leaf is quite long, stands nearly upright, and has a peculiar twist, which no other species has. The hood, instead of being open as in *S. purpurea*, or simply covering the opening, is a vaulted arch, projecting over so far that the only entrance to the tube, in the largest leaves about an inch in diameter, is immediately beneath. In front of this opening are two very peculiar appendages, spreading out on each side, and likened to a fish-tail or a butterfly's wing. The top of the arch and the upper part of the tube is spotted in a peculiar manner with white spots.

This plant, like the others, secretes a sugary matter on the inside of the peculiar projections, which are also covered with bristles. And this sugary secretion, as in the *S. variolaris*, extends from the orifice, down the wing to the ground. The insects which are

principally found in these tubes are flyers, moths, etc., and in attracting these the peculiar fish-like projections are doubtless of great use. Besides being conspicuous from their size, they are brightly colored and peculiarly mottled. The moth, attracted by the conspicuous appendages, alights and feeds on the honey. Entering the tube, as it is almost sure to do, and afterward attempting to escape, it is prevented by the over-arching hood and falls into the tube. Here it finds the same sort of hairs described in Sarracenia, and is wedged deeper and deeper into the tube, to be finally drowned in the fluid secreted at the bottom. The peculiar twist is probably to wedge the insect more firmly into the tube, and make it more impossible than ever for it to find its way to the top. The peculiar white spots on the arch, and at the back, are supposed to be for the purpose of misleading the insect. The sun-light striking through them would make it appear a more conspicuous opening than the real one below, and by striking their heads against these simulated skylights they would be more likely to be knocked into the tube.

The flowers are solitary at the top of a bracted scape, of the color of the flap of the pitcher, and the organs are arranged in such a manner as to entirely prevent it being fertilized except by the aid of insects. Dr. Hooker, in speaking of these flowers, remarks that he was struck "with a remarkable analogy between the arrangement and coloring of the parts of the leaf and of the flower. The petals are of the same color as the flap of the pitcher, and between each pair of petals is a hole (formed by a notch in the opposed margins of each), leading to the stamens and stigma. Turning to the pitcher, the relation of its flap to its entrance is somewhat similar. Now, we know that colored petals are specially attractive organs, and that the object of their color is to bring insects to feed on the pollen or nectar, and in this case by means of the hole to fertilize the flower; and that the object of the flap and its sugar is also to attract insects, but with a very different result, cannot be doubted. It is hence conceivable that this plant lures insects to its flowers for one object, and feeds them while it uses them to fertilize itself, and that, this accomplished, some of its benefactors are thereafter lured to its pitchers for the sake of feeding itself!" (*Nature*, vol. x., 1874, p. 370).

Who can deny now that we have not to deal here with a marvelous order of plants? Every member of it has some peculiar

feature, and the means used to accomplish the same end is a striking instance of the diversity in nature. While in one species it is a poisonous honey which intoxicates the insect and causes it to fall into the tube; in another it is, perhaps, a poisonous secretion of the flower, which answers the same purpose; in a third, it is a baited pathway which lures the insect to destruction and a stupefying liquid which decomposes the bodies of the same; and in a fourth, it is the simulation of the wings of an insect, as well as honey and a baited pathway which attracts the prey. What doubt can there be, but that all these contrivances subserve the same end? And when, too, we consider the curious relation between the flower and the leaf in Darlingtonia, and the very different shape of the flower in Sarracenia, we see there must be still other facts to be discovered. Such an abnormal stigma as is possessed by the Sarracenia can not but be of some use. With its broad, flat table like expansion, most effectually concealing the stamens behind it, it is utterly incapable of self fertilization. There must be some relation between it and the leaves, but what this is, is at present a mystery. Then to trace the evolution of the leaves from the normal shape to the present peculiar one, would be of interest, but space forbids, and leaving this matter for some future time we take leave of this fascinating subject.

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EDITORS' TABLE.

EDITORS: A. S. PACKARD, JR., AND E. D. COPE.

—— Owing to the almost isolated position of the United States as a nation, there is less stimulus to the development of a sentiment of nationality here than in the case of the European nations. Emulation and rivalry have had a great deal to do with progress in Europe. It has been asserted that the absence of such competition on this continent will work to the injury of the advancement of the United States, in matters intellectual at least. It is true that the character of our institutions is such as to stimulate the energetic prosecution of enterprises in all directions; but success here will only meet with financial rewards, unless there be some sentiment of national pride in the results of intellectual success, which is not directly connected with the making of money. For the successful discoverer in the field of pure science, Europe has greater rewards than America.